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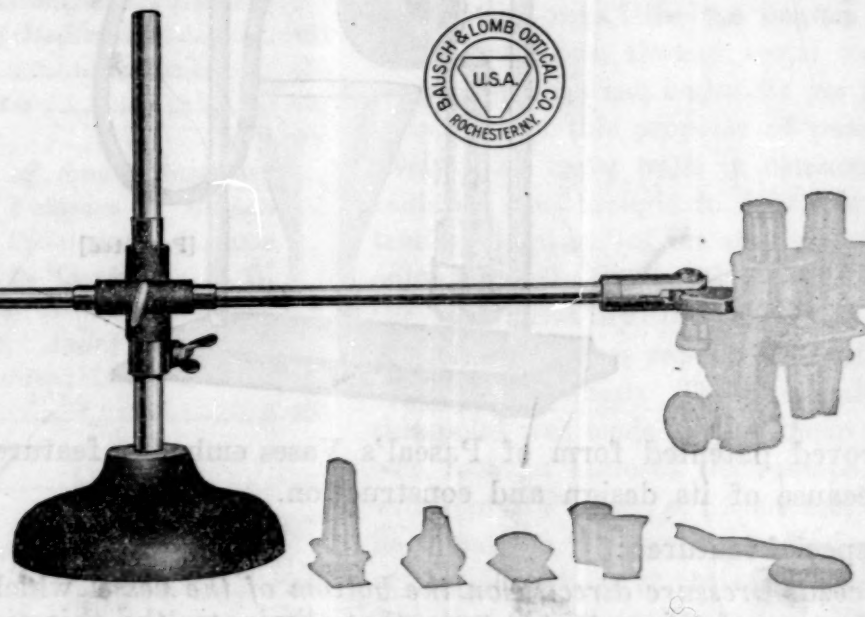

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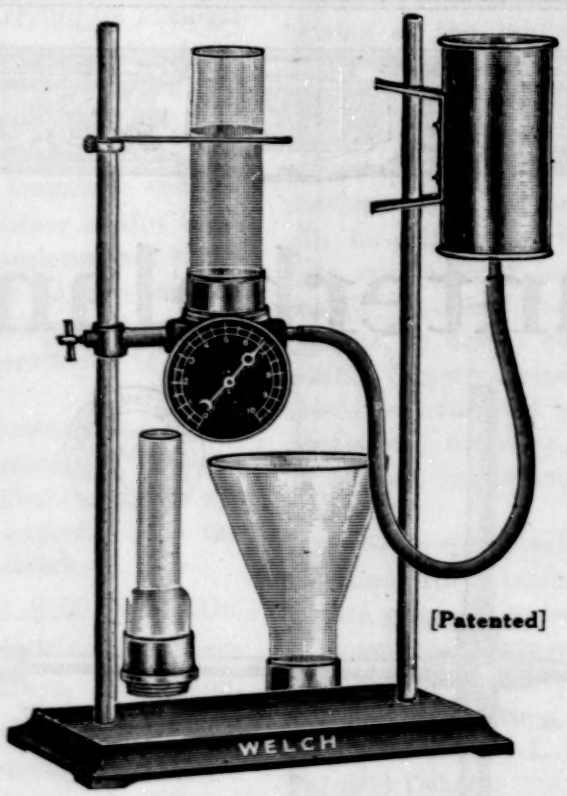

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HIGH FREQUENCY RAYS OF COSMIC ORIGIN[1]

IT was as early as 1903 that the British physicists, Rutherford and McLennan, noticed that the rate of leakage of an electric charge from an electroscope within an air-tight metal chamber could be reduced by enclosing the chamber within a completely encircling metal shield or box with walls a centimeter or more thick. This meant that the loss of charge of the enclosed electroscope was not due to imperfectly insulating supports, but must rather be due to some highly penetrating rays, like the gamma rays of radium, which could pass through metal walls as much as a centimeter thick and ionize the gas inside.

In view of this property of passing through relatively thick metal walls in measurable quantity, the radiation thus brought to light was called the "penetrating radiation" of the atmosphere, and was at first quite naturally attributed to radioactive materials in the earth. But in 1910 and 1911, it was found that it did not decrease as rapidly with altitude as it should upon this hypothesis. The first significant report upon this point was made by a German physicist, Gockel, who took an enclosed electroscope up in a balloon with him to a height of 13,000 feet and reported that he found the "penetrating radiation" about as large at this altitude as at the earth's surface, despite the fact that Professor Eve, of McGill University, had calculated that it ought to have fallen to half its surface value in going up 250 feet.

In 1912, 1913 and 1914, two other German physicists, Hess and Kohlhorster, repeated these balloon-measurements of Gockel's, the latter going to a height of 9 km., or 5.6 miles, and reported that they found this radiation decreasing a trifle for the first two miles and then increasing until it reached a value at 9 km., according to Kohlhorster's measurements, eight times as great as at the surface. This seemed to indicate that the penetrating rays came from outside the earth, and were therefore of some sort of cosmic origin. The war put a stop the world over to further studies of this sort, but as soon as we could get the proper instruments built after the war in the newly equipped Norman Bridge Laboratory of Physics, I. S. Bowen and myself went to Kelly Field, near San Antonio, Texas, with four little recording electroscopes which we succeeded in the spring of 1922 in

[1] Read to the National Academy of Sciences, Madison, November 9, 1925. Copyright, 1925, by Science Service, Inc.

sending up in sounding balloons to almost twice the heights which had previously been attained. The highest flight reached the altitude of 15.6 km., or nearly 10 miles.

These instruments were interesting in that, though they were built to hold 300 cubic centimeters of air at 150 pounds pressure, and were provided each with a recording barometer, thermometer and electroscope, also with three different sets of moving photographic films and the necessary driving mechanism, the total weight of the whole instrument was yet but 180 grams, or about 7 ounces.

In these experiments we expected, if the results previously reported were correct, to find very large rates of discharge; for our instruments went up to such heights that nine tenths of the atmosphere had been left beneath them, and only one tenth was left to cut down, by its absorption, the intensity of the hypothetical rays entering from outside. The results were contrary to this expectation. They proved conclusively, however, in agreement with the observations of Hess and Kohlhorster, that the penetrating radiation was greater at great altitudes than at the surface, but that the amount of the increase was not more than a fourth of that predicted from the results of the German observers. (Two years later they reduced their estimates, after further experiments, so that they were no longer in conflict with our measurements.)

Since the origin of the rays was still uncertain, with indications in favor of some cosmic source, Mr. Russell Otis and myself felt that the next step was to find out how penetrating the rays were; and since they were weaker at the surface than higher up we went to the top of Pike's Peak in the summer of 1923, carrying up 300 pounds of lead and a big 6 x 6 x 6-foot water tank for the sake of making absorption measurements on such rays as were found at that altitude.

We found that though our electroscopes discharged twice as fast on Pike's Peak as at the altitude of Pasadena, the rays were cut down so fast by our absorbing screens that it was certain that the greater part of them were not much if any more penetrating than the ordinary gamma rays emitted by radium. We found, further, that the rate of discharge of our electroscope was decreased by ten per cent. by a heavy snow storm which occurred during the week in which we were on the peak. This showed conclusively that the chief part, at least, of the rays with which we were experimenting on the peak were of local origin, and that they might be due to radioactive matter which in some unknown way got into the upper regions of the atmosphere.

The search for the cause of the increase with altitude in the intensity of these soft gamma-like rays became, therefore, quite as interesting as the question of the existence of a very penetrating radiation of cosmic origin, since this latter would produce at the most but a fraction, and no large fraction either, of the observed increase between Pasadena and Pike's Peak. Mr. Harvey Cameron and I therefore planned experiments for the summer of 1925 which were designed (1) to settle definitely the question of the existence or non-existence of a small, very penetrating radiation of cosmic origin, and (2) to throw light on the cause of the variation with altitude of the softer radiation of the gamma ray type which we had found more than twice as intense on Pike's Peak as at Pasadena.

To bring to light the very penetrating radiation, if it existed, it was necessary to find at very high altitudes very deep snow-fed lakes, for any radioactive contamination of the water through its seepage through the earth would vitiate the results obtained by sinking electroscopes to different depths beneath the surface of the lake.

We chose for the first experiment Muir Lake (11,800 feet high), a beautiful body of water hundreds of feet deep just under the brow of Mount Whitney, the highest peak in the United States. Here we worked for the last ten days in August, sinking our electroscopes to various depths down to 60 feet. Our experiments brought to light altogether unambiguously a cosmic radiation of such extraordinary penetrating power that the electroscope reading kept decreasing down to a depth of 45 feet below the surface. The atmosphere above the lake was equivalent in absorbing power to 23 feet of water, so that we had found rays, coming into the earth from outer space, so penetrating that they could pass through 45 plus 23, equalling 68 feet of water or the equivalent of 6 feet of lead, before being completely absorbed. This represents rays much harder (more penetrating) than any which had before even been imagined.

The most penetrating X-rays which we produce in our hospitals can not go through half an inch of lead. Here were rays originating somewhere out in space, at least a hundred times more penetrating than these.

Further, high penetrating power means, according to modern physics, simply high frequency or short wave-length. Our experiments indicate, then, that there is a region of frequencies as far up above the X-ray frequencies as are these latter above the frequencies of light waves.

They show quite definitely, too, that these highest frequency rays are not homogeneous, but have a measurable spectral distribution, the shortest waves which we observed being a little less than twice the frequency of the longest, for the rays which we actually observed in Muir Lake changed hardness or frequency as they were filtered through greater and greater

thicknesses of water, just as X-rays are successively hardened by passing through successive layers of lead. The experiments with the sounding balloons indicates that the frequencies of these cosmic rays do not extend over into the X-ray region of frequencies, else we should have obtained larger discharges in the experiments with sounding balloons when nine tenths of the atmosphere had been left beneath us.

Further, we obtained good evidence that these cosmic rays shoot through space in all directions, this evidence being found in the fact that we could observe no change whatever in their intensity throughout day or night.

All the results obtained in Muir Lake were checked with wonderful completeness by another set of observations in another snow-fed lake—Arrowhead Lake—300 miles away from Muir, 7,000 feet lower, and equally deep, where the Arrowhead Lake Development Company kindly put all their facilities at our disposal. Indeed, the absorbing power of the atmosphere between the elevations of Muir and Arrowhead lakes is the equivalent of about two meters of water, and as a matter of fact every reading in Arrowhead was practically identical with one taken in Muir at a depth two meters lower.

We can draw some fairly reliable conclusions as to the origin of these very penetrating and very high frequency rays. The most penetrating rays that we have known anything about thus far, the gamma rays of radium and thorium, are produced only by nuclear transformations within atoms. This means that they are produced by the change of one atom over into another atom, or by the creation of a new type of atom. It is scarcely possible then, to avoid the conclusion that these still more penetrating rays which we have here been studying are produced similarly by nuclear transformations of some sort. But these transformations must be enormously more energetic than are those taking place in any radioactive changes which we know anything about. For the frequency of any emitted ray is, according to our present knowledge, proportional to the energy of the subatomic change which gives birth to it. We can scarcely avoid the conclusion, then, that nuclear changes having an energy value perhaps fifty times as great as the energy changes involved in observed radioactive processes are taking place all through space, and that signals of these changes are being sent to us in these high frequency rays.

The energy of the nuclear change which corresponds to the formation of helium out of hydrogen is known, and from it we have computed the corresponding frequency and found it to correspond closely to the highest frequency rays which we have observed this summer. The computed frequencies of these rays also correspond closely to the energy involved in the simple capture of an electron by a positive nucleus. It is possible that this phenomenon is actually going on all through space. This is I think the most probable source of these rays. It is true that the formula underlying this computation of the frequencies of these rays from their absorption coefficient is of uncertain validity. It is a formula, nevertheless, that works well in the frequency range in which we can get independent checks upon it, namely in that of the X-ray field and the gamma ray field.

According to this formula the wave length of the shortest waves which we have here investigated is .0004 Angstroms, or but one fiftieth of that of the hardest gamma rays heretofore known, and but one ten millionth that of ordinary light. The longest wave length which we have found is about five thirds of the shortest, or .00067 Angstroms.

When these extraordinarily high frequency rays strike the earth, according to the now well-established Compton effect, they should be transformed partially into soft scattered rays of just about the hardness, or the wave length, of the soft rays which we have actually observed on Pike's Peak and Mount Whitney. The reason these soft rays were more plentiful on the mountain peaks than at Pasadena would then be found simply in the fact that there are more than twice as many of the hard rays to be transformed at the altitudes of the peaks than at that of Pasadena. This seems to be the solution of the second of our summer's problems.

But how can nuclear transformation, such, for example, as the formation of helium out of hydrogen or the capture of an electron by a positive nucleus, be going on all through space, the resulting rays coming apparently as much from one direction as from any other, and certainly not a whit more plentifully from the direction of the sun than from that diametrically opposite to it, as evidenced by the entire equality of our midday and midnight observations? The difficulty is not so insuperable, in view of the transparency even of large amounts of matter for these hard rays, combined with Hubble's recent proof at the Mount Wilson Observatory that some of the spiral nebulae are at least a million light years away. The centers at which these nuclear changes are taking place would then only have to occur at extraordinarily widely scattered intervals to produce the intensity of the radiation observed at Muir Lake.

The only alternative hypothesis to that above presented, of high frequency rays traversing space in all directions, might seem to be to assume that the observed rays are generated in the upper layers of the atmosphere by electrons shooting through space in all

directions with practically the speed of light. This hypothesis might help in interpreting the mysterious fact of the maintenance of the earth's negative charge, but it meets with insuperable obstacles, I think, in explaining quantitatively the variation with altitude of the ionization in closed vessels. In any case, this hypothesis is, in its most important aspect, very much like the one represented above, for it, too, fills space with rays of one sort or another travelling in all directions with the speed of light. From some such conception as this there now seems to be no escape. And yet it is a conception which is almost too powerful a stimulus to the imagination. Professor MacMillan, of Chicago, will wish to see in it evidence for the condensation into matter out somewhere in space of the light and heat continually being radiated into space by the sun and stars, and the psychists will be explaining all kinds of telepathic phenomena by it.

In any event, our experiments seem to point to the following conclusions: (1) That these extraordinarily penetrating rays exist; (2) that their mass absorption coefficient may be as high as .18 per meter of water; (3) that they are not homogeneous, but are distributed through a spectral region far up above X-ray frequencies—probably 1,000 times the mean frequencies of X-rays; (4) that these hard rays stimulate, upon striking matter, softer rays of about the frequency predicted by the theory of the Compton effect; (5) that these rays come into the earth with equal intensity day and night and at all hours of the day or night, and with practically the same intensity in all directions.

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COORDINATION OF THE HEALTH ACTIVITIES OF THE FEDERAL GOVERNMENT[1]

THE government machine, like the human mechanism, requires an occasional physical inventory. Such a health examination is in fact now being performed on our national government and is producing some interesting results. Just as a human appraisal, made by a doctor of medicine, frequently brings out latent physical impairments, so too this survey of governmental health functions, made by doctors of political science and of public health, discloses many administrative defects. Just as health examinations of individuals, now so strenuously advocated by physicians and sanitarians, usually indicate possibilities for physical improvements, so too this political inspection points the way to the desirability of a more effective centralization or correlation of the public health and medical activities of the government of the United States.

The promotion of national vitality is conceded to be one of the principal interests of any sovereignty. In the United States the care of the public health is, under our form of government, vested primarily in the individual states as a part of their police power. The federal establishment does, however, have certain legitimate public health activities, sanctioned by the Constitution and imposed by Congress under that authority. These duties include the power over interstate matters, involving the prevention of the spread of disease from one state to another; a similar power of foreign quarantine, that is, prevention of the introduction of disease from without; the control of the health of the people of federal territories and reservations; health powers incidental to taxation; public health matters involved in treaties; and, finally, scientific research, popular health instruction and cooperation and counsel for state and local health authorities on request.

All these duties are now exercised by the national government without in any way conflicting with state autonomy in public health matters. Of the hundred or more major administrative units of the federal service, at least thirty bureaus, divisions or other branches of the government are concerned directly or indirectly with some phase of the public health. In many instances, of course, the health work may be only incidental to other more important functions, or the health activities may constitute a relatively minor issue. Only eight of these thirty bureaus may be said to carry on health duties as their major object. These eight bureaus are, nevertheless, located in five different executive departments, and all the health activities of the government are scattered throughout the ten cabinet departments and a number of independent establishments.

The eight government bureaus or divisions whose public health activities may be said to be of major scope are as follows:

Public Health Service, Treasury Department.

Children's Bureau, Department of Labor.

Medical Division, Office of Indian Affairs, Department of the Interior.

Division of School Hygiene, Bureau of Education, Department of the Interior.

Division of Vital Statistics, Bureau of the Census, Department of Commerce.

Bureau of Chemistry, Department of Agriculture.

Bureau of Home Economics, Department of Agriculture.

[1] Read before Medical Section, Southwestern Division, American Association for the Advancement of Science, Boulder, Colorado, June 10, 1925.

Bureau of Animal Industry, Department of Agriculture.

Among other federal bureaus having an important interest in public health there should be particularly mentioned the Bureau of Mines, recently transferred from the Department of the Interior to the Department of Commerce; St. Elizabeth's, the Government Hospital for the Insane, under the Department of the Interior; the Bureau of Dairying, and the Extension Service, both in the Department of Agriculture; and the Bureau of Labor Statistics, in the Department of Labor. Other bureaus having a real but less significant public health interest are the Consular Service, State Department; Customs Service, and Bureau of Internal Revenue, Treasury Department; Bureaus of Public Roads and Entomology, Department of Agriculture; Bureau of Fisheries, Department of Commerce; and Women's Bureau and Bureau of Immigration, Department of Labor. In addition, there are many other branches of the government which have a casual interest in the public health. The government also administers a number of activities which cover medical relief rather than public health, or preventive medicine, such as those of the Veterans' Bureau, the Employees Compensation Commission, the Alaska Division of the Bureau of Education (Interior), Freedmen's Hospital (Interior) and several of limited or special public health scope, such as the medical services of the army and navy.

These many health and medical activities are the products of political evolution. They have arisen from time to time during the last century and a quarter and have been deposited in this or that department as the opportunity has arisen. In the period of years since 1798 when an act was passed authorizing collectors of customs to assess every seaman of the American merchant marine twenty cents a month for medical relief, Congress has added nearly one hundred laws relating to national health to the statute books. These acts have imposed various duties and have required the establishment of bureaus or other administrative units to put them into effect. Out of the act of 1798, for instance, evolved the Marine Hospital Service, though it was not definitely organized as such until 1870. The scope of this bureau was gradually broadened until in 1912 its name was changed to Public Health Service in recognition of the domain of its work. To-day it is the chief health agency of the government, and, as indicated, in the Treasury Department for historical reasons only.

The Children's Bureau was created in 1912 to investigate and report on all phases of child welfare. It also administered the first federal child labor law until it was declared unconstitutional, and in 1921, when Congress passed the Federal Maternity and Infancy Act, the scope of the Children's Bureau was greatly extended by virtue of being charged with the administration of this law. Vital statistics, often called the book-keeping of public health, are used and interpreted by both the Children's Bureau and the Public Health Service, but they are collected by a division of the Bureau of the Census. The Children's Bureau concerns itself with the health and welfare of mothers and children through the preschool age. Studies of the health of school chilldren are undertaken by the Bureau of Education of the Interior Department, and also, it might be remarked, by the Public Health Service. Nutritional experiments are conducted by the Bureau of Home Economics, the Department of Agriculture having been authorized to make such investigations as early as 1894. The pure food and meat inspection laws of 1906 placed new responsibilities on this department, exercised by the Bureaus of Chemistry and Animal Industry, respectively.

The federal executive departments, as at present constituted, have been likened to an old rambling mansion, constructed in 1789 and added to ever and anon without any regard whatsoever to the architecture of the structure and with very little thought as to its utility. Every president from the time of Roosevelt has urgently recommended the reorganization of the federal executive departments; scientific surveys and reports have been made by official and extra-governmental agencies; but Congress has not yet seen fit to pass the necessary legislation, though it has held copious hearings on various bills relating to reorganization.

No really practical plan has been proposed in the past for the correlation of the federal health activities. In 1910 a group known as the Committee of One Hundred of the American Association for the Advancement of Science attempted to sponsor a national bureau of health, with a secretary in the cabinet. President Taft espoused the movement and endorsed it in two messages to Congress, but that body refused to adopt the suggestion. The country had some precedent for such a bureau, for at one time there was a National Board of Health. It was created in 1879 for a four year period, its duties restricted in 1882 to investigations of cholera, yellow fever and smallpox, and the law establishing the board was repealed in 1893 after it had been dormant for a decade. Many other bills and proposals for a national health department have been before Congress but have received scant, if any, attention.

Most of the schemes of the past relating to the glorification of national health activities have suggested a considerable expansion of them, with insinuations of larger appropriations. While nothing is

more important than the health of the nation, there is no urgent reason at the present time for insisting upon a great increment in either the scope or the expenditures for federal health. It is even of doubtful expediency to advocate a new executive department devoted to the subject, ideal as that might be. It is, however, eminently practical and entirely feasible to suggest that those bureaus already actually doing public health work should be more efficaciously coordinated. This would mean no branching out; if properly consummated it could demonstrate real economy, as well as more efficient production with the same facilities. Certainly we can agree that some form of correlation is desirable, in fact essential, and that whatever form of coordination appears best, it should be administered under central direction, possibly by an assistant secretary of public health. Such an official should be, moreover, a trained sanitarian.

To outline in detail a plan for this correlation of federal health resources would be premature. Such a proposal must come only after a most thorough examination of the existing organization and activities of the various bureaus concerned. An intensive survey of our present federal health work is now being made under the auspices of the Institute for Government Research of Washington, D. C., which has been studying the organization of the government for the past ten years. A report will be issued in the fall of this year. The next step will then be to formulate a practical plan, based on a complete knowledge of the facts. To accomplish this, the advice of many government officials, experts in political science, leading sanitarians, members of the medical profession, and scientists generally must be secured. After a plan has been agreed upon, as far as possible, the final step is to induce Congress to adopt it, and in adopting it not to amend it too drastically. This program may require several years, but the goal seems worth the effort.

Public health is of no less importance in the affairs of this nation than is commerce, labor, agriculture, public works, finance, foreign affairs, the common defense or justice. All these important aspects of government have been properly accorded the recognition due them, but the same can not be said for health or education. A deficient national vitality reduces the scope and significance of all these other elements, for an A1 nation can not be produced on a C3 vitality, and ours, advanced as it is, still leaves considerable to be desired. It seems not unreasonable, therefore, to hope and expect that the public health will be recognized on a plane equivalent to these other undeniably significant phases of government. When it is considered that some fifteen million dollars is expended annually by our national government on health matters, but that more than three times as much, or about fifty millions, is appropriated for medical relief, the thought will not down that possibly a more efficient system of prevention would reduce the amount needed for cure. This fifteen millions is, furthermore, only one half of one per cent of our total yearly budget of over three billion dollars. An economy which by curtailing funds for prevention makes necessary inflated grants for relief is a false economy.

Science has nowhere to its credit any greater achievements than in the domain of public health. The future in the age-long struggle for the prolongation of human life, the promotion of health and happiness and the enjoyment of living, and the enhancement of national vitality and virility holds out many alluring and fascinating possibilities. For the most effective accomplishment, a true type of scientific leadership is essential and this can best be furnished by a unified, efficiently organized, properly manned, adequately supported federal health service, which could, furthermore, supply this needed impetus, this scientific guidance, without interfering in any way with the autonomy of the states in public health.

"Give me health and a day," wrote Ralph Waldo Emerson, "and I will make the pomp of emperors ridiculous." And so the people of this country, paraphrasing the words of the great philosopher, may say to their Congress, "Give us health and a day and we will make this, the United States, the greatest and the most mighty of the nations in the history of civilization."

JAMES A. TOBEY
INSTITUTE FOR GOVERNMENT RESEARCH,
WASHINGTON, D. C.

JAY BACKUS WOODWORTH[1]

ON August 4, 1925, Jay Backus Woodworth passed away in the sixty-first year of his age, after a disabling illness of nine months. He was the son of the Reverend Allen Beach Woodworth and was born at Newfield, New York, January 2, 1865. As a boy, Woodworth became engrossed in the geological phenomena of his native state; on its hillsides was developed his love for outdoor nature, an enthusiasm for securing first-hand facts by observation in the field. This essential for a successful career in geology was always his own guiding principle and, with word and numberless self-sacrificing acts, he taught the principle to the thousands of Harvard men who took his courses.

1 Minute placed upon the records of the Faculty of Arts and Sciences, Harvard University, at the meeting of October 27, 1925.

After a few years spent in the business world, Woodworth entered the Lawrence Scientific School, to begin his technical training. His worth was speedily recognized by Nathaniel S. Shaler, who appointed him his personal assistant in a prolonged study of the geology of the New England coast, and in 1890 secured Woodworth's appointment as assistant in geology. Three years later Woodworth was promoted to an independent instructorship. He received the degree of S.B. *cum laude* in 1894. He became assistant professor in 1901, and associate professor in 1912. Throughout much of the time since 1890 he was connected with the United States Geological Survey; the results of this national service have been published in a series of memoirs, but one of the most important of these is now awaiting publication at Washington.

Woodworth's researches were largely concerned with glacial geology, in which he became the recognized authority for New England. As a labor of love, he undertook the rather arduous task of organizing and continuously administering the Harvard Seismographic Station, which has been in uninterrupted operation since 1908. Woodworth was one of the American pioneers in the scientific study of earthquakes; the records from his station are among those most prized by the seismologists of the whole world. A special feature of his records is their accurate timing, for which he secured the vital cooperation of the Harvard Astronomical Observatory. As our leading expert on seismology, Woodworth's opinion that neither human history nor the relevant facts of geology indicate serious danger for the city of Boston from earthquakes is significant.

Another of his leading contributions to science was a prolonged exploration in the geology of Brazil and other parts of South America. This expedition was financed by the Shaler Memorial Fund, which is controlled by the division of geology. It is appropriate that Woodworth was the first investigator to be aided by this fund, for he was the trusted friend of his master, Shaler, who organized the present department of geology and geography at the university. The outstanding result of the South American expedition was addition to our knowledge of the remarkable glaciation of Argentina and Southern Brazil near the close of the Paleozoic Era. Other results refer to the structure of the earth's crust in the southern continent. Woodworth had already done much work on the structural geology of New England.

So much for his service to the university, the place of research. Perhaps even more valuable was his service to the college, the place of training in the elements of thinking. For nearly thirty-five years he gave his time and energy unstintedly to the hundreds of undergraduates who each year have thronged the geological laboratories. Others enjoyed the privilege of his leadership during many years when the summer course of field geology was held in Montana. It is impossible to describe adequately the benefit to the college of Woodworth's unceasing humanness, patience and abiding interest in the host of his students.

Woodworth was a member of the National Research Council, his most important contribution to the work of the council being perhaps his service as chairman of the committee on the use of seismographs in war, 1917–18. He was active in the American Association for the Advancement of Science and in the administration of the Geological Society of America, of which he was long a fellow. He was a member of the American Academy of Arts and Sciences; past president of the Seismological Society of America; a member of the Washington Academy of Sciences, of the American Geophysical Union, the Meteorological Society of America, Boston Society of Natural History and other societies.

Woodworth's colleagues in the division of geology knew best his full worth and specially mourn the loss of a valued friend and a many-sided worker, whose place no one man can fill.

REGINALD A. DALY,
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Committee.

SCIENTIFIC EVENTS

THE INSTITUTE FOR THE STUDY OF THE HISTORY OF CIVILIZATION

AT Oslo, Norway, the Institutet for Sammenlignende Kulturforskning (Institute for the Study of the History of Civilization) completed the following courses on October 21, 1925:

Boas (New York): Primitive art.
Karlgren (Göteborg): Sprokvetenskapen och det gamla China.
Mauss (Paris): La notion de civilisation primitive.
Meinhof (Hamburg): Die Religionen der afrikanischen Völker.
Starbuck (Iowa, U. S. A.): Introduction to the science of religion.
A. W. Brogger (Oslo): Den norske oldtidskultur.
Chr. Collin (Oslo): Folkenes fromgang of forfall.

The institute announces the following purpose: The Institute for Comparative Research in Human Culture shall be a free and independent institution having as its object the promotion of research within the fields denoted by its title: comparative study of

languages, the comparative study of folk-lore, the comparative study of religion, the comparative (ethnology) study of law, ethnology, the comparative study of archeology and the comparative study of society. To these may be added other comparative studies of civilization in so far as the board shall deem advisable.

The board shall: (a) Arrange for lectures to be given at the institute by Norwegian or foreign men of science. (b) Publish scientific literature. (c) Offer prizes to be competed for. (d) Appoint Norwegian or foreign men of science to be members of the institute. (e) Award prizes for scientific work done by Norwegian men of science or by foreigners associated with the institute. (f) Give scholarships and other forms of assistance to Norwegian men of science or to foreigners associated with the institute.

The institute publishes two series of volumes: Series A, Lectures, and Series B, Monographs. Two volumes in each series have appeared to date.

P. E. GODDARD

THE PEKING SOCIETY OF NATURAL HISTORY

IN response to a call for a meeting of those interested in the formation of an organization for encouraging the study of the natural history of China, a large number gathered in the lecture room of the department of anatomy of the Peking Medical School, September 21. Dr. A. W. Grabau, who was the enthusiastic promoter of the plan, called the meeting to order at 5:10 p. m. In his opening remarks Dr. Grabau enumerated the existing scientific organizations in China at present and stated that he felt that there was a need for the Peking Society of Natural History. The chairman then called upon Dr. W. H. Wong, Mr. R. Chapman Andrews and Mr. Walter Granger, all of whom spoke in hearty approval of the organization of the proposed society.

Following a brief discussion of the name of the organization, it was voted to adopt the name first proposed, "The Peking Society of Natural History"; the proposed constitution was read and was finally adopted.

The society then proceeded to the election of officers for the coming year and the following were chosen:

President, Dr. G. D. Wilder.
1st Vice-president, Dr. W. H. Wong.
2nd Vice-president, Mr. Sohtsu G. King.
Secretary-Treasurer, Mr. N. Gist Gee.

The following councillors were also elected: Dr. A. W. Grabau, Professor S. C. Lee, to serve three years; Dr. R. K. S. Lim, Dr. H. H. Tan, to serve two years; Dr. Davidson Black, Mr. K. K. Chung, to serve one year.

Upon the completion of the organization of the society, Dr. Wilder addressed the meeting upon the subject "Some common birds of Peking." Dr. Wilder had a number of mounted specimens of the Chinese birds and colored plates of a number of closely related American birds. An interesting feature of the illustrations was some copies by Mr. Kungpah King of ancient Chinese paintings of birds. These were so accurate that in many instances the birds can now actually be identified from them. At the conclusion of the meeting a vote of thanks was extended to Dr. Wilder for his interesting address.

N. GIST GEE,
Secretary-Treasurer
CHINA MEDICAL BOARD, PEKING

FIELD MEETING OF THE ASSOCIATION OF AMERICAN STATE GEOLOGISTS

THE annual fall field meeting of the Association of American State Geologists was held from October 12 to 16 in eastern Pennsylvania, the Pennsylvania Geological Survey acting as host. Early arrivals were entertained on Sunday evening at the homes of Dr. George H. Ashley and Mr. R. W. Stone. Four days were spent in the vicinity of Harrisburg, Hummelstown, Cornwall, Port Clinton, Pottsville, Mahanoy City, Hazeltown, Mauch Chunk, Lehigh Gap, Slatedale, Northampton and Nazareth in observing the excellent exposures of the stratigraphy and structure and the remarkable peneplain remnants and in reviewing the mineral resources of that part of the state, including the southern anthracite field, the slate area, brownstone quarries, cement plants and the Cornwall magnetite mine. The evenings were devoted to discussions of matters pertaining to state survey policies and activities and to discussions of the geological problems of the areas covered. The state geologists were accompanied by a number of guests, including Dr. W. C. Mendenhall, chief; Messrs. E. O. Ulrich, Charles H. Butts, G. W. Stose and Miss Jonas, all of the U. S. Geological Survey; Dr. David White, chairman of the division of geology and geography, and Dr. Albert L. Barrows, chairman of the division of states relations of the National Research Council; Professor W. H. Bucher, of the University of Cincinnati; Professor B. L. Miller, of Lehigh University; Judge James R. MacFarlane, of the Court of Common Pleas, Pittsburgh, and M. W. Twitchell, of the Pennsylvania Geological Survey. The following state geologists represented their respective surveys: George H. Ashley, Herman Gunter, H. B. Kummel, M. M. Leighton, Raymond Moore, Wilbur A. Nelson and David Reger (representing I. C. White). The meeting closed at Bethlehem, Pa., with a dinner at Hotel Bethlehem, at which

President Richards, of Lehigh University, and a number of the faculty were present.

The association acknowledges the many helpful courtesies extended by the various mineral industries visited.

M. M. LEIGHTON, *Secretary,*
Association of American State Geologists

LECTURES ON MENTAL HYGIENE AT THE NEW YORK ACADEMY OF MEDICINE

A COURSE of fifteen lectures on mental hygiene is being given at the Academy of Medicine, 17 West 43rd Street, New York City, on Tuesday afternoons, at 4 o'clock, from November 10 to March 2, inclusive. The course is under the auspices of the New York State Committee on Mental Hygiene, New York Neurological Institute and the National Committee for Mental Hygiene. It has been arranged at the request of the Catholic Big Sisters, the Jewish Big Sisters, the Protestant Big Sisters, the Charity Organization Society and Y. W. C. A. and Y. M. C. A. of New York City. The object of the course is to give those engaged in social, educational and religious work an intelligent understanding of mental hygiene in its application to the problems with which they deal. Each lecture will be followed by a half-hour consultation period.

The program is as follows:

Development in the light of heredity and eugenics, by EDWIN GRANT CONKLIN, professor of biology, Princeton University (November 10).

Mental hygiene and the nursery school, by PATTY HILL, professor of education, Teachers College, Columbia University (November 17).

Mental health and habit training, by DOUGLAS A. THOM, director of the division of mental hygiene, Massachusetts Department of Mental Diseases (November 24).

Habit clinics for problem children, by DOUGLAS A. THOM (December 1).

Some of the emancipation problems of the adolescent, by THOMAS W. SALMON, professor of psychiatry, Columbia University (December 8).

The mental health of the school-age child, by DR. IRA S. WILE, assistant pediatrician, Mt. Sinai Hospital, New York City (December 15).

Juvenile delinquency and mental hygiene, by DR. AUGUSTA F. BRONNER, Judge Baker Foundation, Boston (December 22).

Mental hygiene as a preparation for college life, by DR. ARTHUR H. RUGGLES, lecturer in psychiatry and consultant in mental hygiene, Yale University (January 5).

Mental tests—their uses and interpretation, by DR. PAUL KLAPPER, dean of the school of education, College of the City of New York (January 12).

Applying mental hygiene to the community, by DR. STANLEY P. DAVIES, executive secretary, New York State Committee on Mental Hygiene (January 19).

Inheritance of mental diseases, by ABRAHAM MYERSON, professor of neurology, Tufts College Medical School, Boston (January 26).

Individualism and mental health, by DR. ADOLF MEYER, professor of psychiatry, The Johns Hopkins University (February 9).

New concepts of mental ill-health. by DR. C. MACFIE CAMPBELL, professor of psychiatry, Harvard Medical School, and director of the Boston Psychopathic Hospital (February 16).

Relation of nervous disorders to functional disease, by DR. FOSTER KENNEDY, member of the Medical Board, and attending physician, Neurological Institute, New York City (February 23).

Psychological methods of cure—psychoanalysis, suggestion, etc., by DR. WILLIAM A. WHITE, medical director, St. Elizabeth's Hospital, Washington (March 2).

SCIENTIFIC NOTES AND NEWS

DR. GILBERT NEWTON LEWIS, professor of physical chemistry and dean of the College of Chemistry at the University of California, will give the annual course of eight lectures on the Silliman Foundation at Yale University, beginning on November 30. His subject will be "Concepts of science."

ACCORDING to an Associated Press dispatch from Stockholm, the Nobel prize in physics has been awarded to Dr. Karl Manne George Siegbahn, professor of physics at Lund University, Sweden.

THE Leeuwenhoek medal was presented to Professor d'Herelle, the discoverer of the bacteriophage, at a special meeting of the Dutch Royal Academy of Sciences on September 26.

PROFESSOR V. M. BEKHTEREV, the well-known Russian neurologist and psychiatrist, has celebrated the fortieth anniversary of his activity as a professor. This year also marks the fiftieth anniversary of the date of publication of his first scientific paper.

THE Scientific Department of the Russian Commissariat of Education has sanctioned awards for scientific achievements to Professor Chaplin, for work in connection with the theory of monoplane-wings; Professor F. Orlov, for work on comet-tails; Professor Schtefke, for his work on "The influence of starvation on the child organism," and Professor Chichibabin, for work in organic chemistry.

THE University of Cambridge will confer the degree of doctor of science (*honoris causa*) on Sir T. W. Edgeworth David, professor of geology in the University of Sydney.

DR. J. M. PURSER, Regius professor of physics at Trinity College, Dublin, has retired.

DR. T. WARDROP GRIFFITH, who recently retired from the chair of medicine at the University of Leeds, has been made emeritus professor.

DR. MAURICE OSTHEIMER, assistant professor of diseases of children at the University of Pennsylvania, has retired, having completed twenty-five years of teaching.

DR. OSKAR VON MILLER, director of the Museum of Invention and Vocational Guidance at Munich, Germany, was the guest of honor at a luncheon given by Felix M. Warburg on November 15, at which plans were discussed for the proposed new museum of engineering and industry. Dr. George F. Kunz outlined the ideas of a committee which is fostering the plan.

AS a sequence of the reorganization of the French Weather Service (Office National Météorologique), the International Commission for the Study of Clouds has announced its program of work. Members of the commission are: from Norway, Bergeron T. Bjerknes; Great Britain, Cave Clarke Douglas; Japan, Fujiwahra; Portugal, Chaves; Belgium, Jaumotte; France, Besson, Delcambre, Scherechemskys; Germany, Süring; Italy, Matteuzi, Taffara; Switzerland, Maurer, de Quervain; Esthonia, Konsnetzoff, and United States, McAdie.

AT the annual meeting of the Royal Society of Edinburgh, held on October 26, the following officers were elected: *President,* Sir Alfred Ewing; *Vice-presidents,* Professor J. H. Ashworth, Professor T. H. Beare, Dr. W. B. Blaikie, Sir Robert Blyth Greig, Professor T. H. Bryce and Professor E. T. Whittaker; *General Secretary,* Professor R. A. Sampson; *Secretaries to Ordinary Meetings,* Dr. A. Lauder, Professor W. Wright Smith; *Treasurer,* Dr. J. Currie; *Curator of Library and Museum,* Dr. A. Crichton Mitchell.

DR. H. V. ARNY, professor of chemistry in the College of Pharmacy at Columbia University, has been elected chairman of the National Conference on Pharmaceutical Research.

DR. C. C. BASS, dean of the Tulane University Medical School, was elected president of the Southern Medical Association at the closing session at Dallas, on November 12. Dr. C. M. Marchman, of Dallas, was elected first vice-president.

PROFESSOR FRED R. FAIRCHILD, of Yale University, has been appointed director of the national investigation of forest tax problems, which is to be undertaken under the auspices of the forestry service of the U. S. Department of Agriculture, in accordance with the provisions of the Clark-McNary forest act, passed by the last congress.

W. C. PARKINSON was relieved of the charge of the Huancayo Magnetic Observatory at the end of July in order to take part in the reduction of the observatory observations under way at the office of the Department of Terrestrial Magnetism at Washington. Mr. R. T. Booth was appointed observer-in-charge of the Huancayo Observatory, in succession to Mr. Parkinson, and will be assisted by Messrs. R. H. Goddard and A. H. Kampe.

L. E. WARREN has returned to the U. S. Bureau of Chemistry after an absence of a number of years. During the greater part of this time he has been associate chemist for the American Medical Association. In his new work Mr. Warren will have charge of revising the methods used by government officials in the analysis of drugs.

ADRIAN THOMAS has resigned his position as research chemist with Parke, Davis and Company to accept a position with the Huron Milling Company, of Harbor Beach, Michigan.

LUTHER B. MCMILLAN has been appointed chief engineer of Johns-Manville, Inc., in the department of general engineering and research.

C. P. BLACKWELL, formerly chief agronomist of Clemson College, South Carolina, but more recently connected with the staff of the Soil Improvement Committee of the National Fertilizer Association at Atlanta, Ga., has been transferred to the Shreveport, La., office to have charge of work in the western part of the cotton belt.

CLIFTON S. CORBETT, formerly associate professor of geology at the University of Kansas, was recently appointed chief geologist for the Dutch East Indies subsidiary of Standard Oil Co. (N. J.). Headquarters are at Weltevreden, Batavia, Java.

W. J. ROONEY, associate physicist in the U. S. department of terrestrial magnetism of the Carnegie Institution, has left Washington for the Watheroo Magnetic Observatory, Western Australia, to make there earth-resistivity measurements in connection with the earth-current work.

W. A. HAGAN, professor of veterinary pathology and parasitology at Cornell University, has been granted a leave of absence for the purpose of studying in Europe. Professor Hagan has received a fellowship from the International Education Board.

DR. SMITH ELY JELLIFFE has returned to New York after attending the International Meeting of Psychoanalysts in Bad Homburg and the German Society of Psychiatrists and Neurologists in Cassel. He also visited the neurological and psychiatric clinics of Amsterdam, Vienna, Padua, Milan and Genoa.

R. T. WEBBER and P. B. Dowden, entomologists of the U. S. Department of Agriculture, who have been investigating the gipsy moth and the brown-tail moth and their natural enemies in central Europe

during the last six months, have returned to the gipsy-moth laboratory of the Bureau of Entomology at Melrose Highlands. Forest areas and entomologists were visited in Germany, Poland, Austria, Hungary, Yugoslavia, Czechoslovakia, Bulgaria and Roumania.

PROFESSOR GROBER, head of the Physikalisch-Therapeutische Institut of the University of Jena, is planning to go next summer to Tenariffe to continue work that Professor Engen Fischer, of Freiburg, has been carrying out on the aborigines of the Canary Islands and representatives of the Cro-Magnon race remaining there.

PROFESSOR I. P. IVANOV, Moscow, is soon to leave for French Guinea for research on anthropoids. He has been offered a place in the Pasteur Institute at Kindia, in French West Africa, where there is a simian colony for research.

THE Prussian Meteorological Institute in Berlin and the Geographical Society in Breslau have invited the scientific collaborator of the Polar Commission attached to the Russian Academy of Sciences, A. I. Tolmatchev, to give lectures on his expeditions to Novaya-Zemlya and the Kolguev Islands.

DR. W. W. GRAVES, professor and director of the department of neurology and psychiatry of the St. Louis University School of Medicine, has returned to St. Louis from a trip to the institutions of learning in the British Isles. While abroad, he gave addresses in the University College, London; University of Aberdeen; Queen's College, Dublin; the Biological Club, Dublin, and the Royal Medical Chirognomy Society of Glasgow. The chief purpose of his visit was a response to an invitation to deliver the Henderson lecture at the University of Edinburgh, which was given on October 16.

PROFESSOR W. M. DAVIS, of Harvard University, gave two lectures under the auspices of the Geographic Society of Chicago on November 13, on "The lessons of the Colorado Canyon, or a glimpse through the corridors of time."

DR. FREDERICK O. BOWER, professor emeritus in the University of Glasgow, recently addressed the biological seminar of Rutgers University on the subject "Evidence of inheritance of acquired characters from ferns."

PROFESSOR ERNEST W. BROWN, professor of astronomy at Yale University, gave a lecture on "The recent solar eclipse and its results" at the Franklin Institute, Philadelphia, on November 18.

DR. JAMES B. CONANT, of Harvard University, will address a meeting of the Northeastern section of the American Chemical Society on December 11, on "Recent developments in organic chemistry."

DR. ELMER V. MCCOLLUM, professor of biochemistry, Johns Hopkins University School of Hygiene and Public Health, addressed the Marion County Medical Society, Indianapolis, on October 13, following a dinner given in his honor.

DR. C. G. ABBOT, director of the Astrophysical Observatory, Washington, and secretary of the Smithsonian Institution, delivered a popular lecture before the Royal Meteorological Society on November 11 on "Measuring the sun's rays."

ON November 7, the course of scientific lectures conducted by the Royal Canadian Institute opened with the inaugural address of the new president, Dr. J. J. R. Macleod, F.R.S., his subject being "The science of medicine."

THE Huxley Memorial Lecture of the Royal Anthropological Institute will be delivered on November 24, at the Royal Society, by Sir Arthur Evans, who will speak on "Early Nilotic, Libyan and Egyptian relations with Minoan Crete."

DR. B. A. KEEN, assistant director of the Rothamsted Experiment Station, will give on November 25 the ninth lecture of the series "Physics in industry," under the auspices of the Institute of Physics, London. His subject will be "The physicists in agriculture, with special reference to soil problems."

AN appeal has been issued for donations toward a memorial fund of £2,000 which is being raised to perpetuate the memory of the close association of the late Dr. R. Mullineux Walmsley with the Northampton Polytechnic Institute. It is proposed to erect a tablet or other record of the late principal and to endow a Walmsley Memorial Scholarship.

THE bronze bust of the late Surgeon-General William C. Gorgas, to be presented to the state by the Medical Association of the State of Alabama, has been received at the state health department.

DR. FREDERICK B. PECK, professor of geology at Lafayette College, died on November 9 of heart disease. Professor Peck has been connected with Lafayette College since 1892 and was in his sixty-fifth year.

DR. W. R. A. JOYNER, technical adviser in the Nobel Explosive Works, England, died on October 8, as a result of injuries received while carrying out experimental work on explosives.

DR. JOHN ROBERTSON HENDERSON, formerly professor of zoology in the Madras Christian College,

India, and curator of the Madras Museum, died on October 26 at the age of sixty-two years.

PROFESSOR W. KILIAN, professor of geology and mineralogy in the University of Grenoble and member of the Paris Academy of Sciences, has died, aged sixty-three years.

THE next meeting of the American Astronomical Society will be held at the Eastman Research Laboratory, Rochester, N. Y., on January 1 and 2, 1926.

THE metropolitan section of the American Society of Mechanical Engineers held a meeting at the Engineering Societies Building, New York City, on the evening of November 12. Professor L. B. Breckenridge spoke on "Subterranean heat as a source of power," Dr. George Otis Smith on "Heat rich areas of the United States," J. D. Galloway on "Developing natural steam wells at the geysers, California." Other papers were "The thermodynamics of the flow of subterranean heat," by Geo. A. Orrok, and "Volcanism as a source of power," by Frank A. Perret.

A MEETING of the New York section of the American Chemical Society took place on November 6 at Rumford Hall, New York City, when Professor James Kendall, of Columbia University, spoke on "The separation of the rare earths," and C. B. White, of the Metakloth Company, on "A new use for the rare earths."

THE Western New York Branch of the Society for Experimental Biology and Medicine held its sixteenth annual meeting at Cornell University on October 19. Dr. Walter Bloor, of the University of Rochester, was elected president, and Dr. James B. Sumner, of the department of biochemistry at Cornell, was reelected secretary and treasurer of the organization. Among the speakers were Professor Sutherland Simpson, Professor Samuel A. Goldberg, Dr. Joseph A. Dye and Dr. Howard S. Liddell.

DR. AND MRS. C. G. ABBOT sailed on October 31, by Royal Mail Steamer *Orbita,* for England, on the way to the Eastern Hemisphere for the purpose of investigating desirable sites for a new solar radiation station. Dr. Abbot's journey is undertaken at the expense and on behalf of the National Geographic Society which is furnishing a grant for the establishment and maintenance over a period of several years of a solar radiation station similar to those which the Smithsonian Institution is maintaining in California and Chile. Dr. and Mrs. Abbot intend to proceed first to England, where he will lecture before the Royal Meteorological Society, thence to France and Algeria, thence to Egypt and Bombay, India, and to Delhi and to Quetta in Baluchistan. Returning to Bombay, they will proceed to Durban in Natal, to Cape Town and what was formerly German Southwest Africa, thence returning by way of England to New York. It is probable that the journey will be completed about May 1, 1926.

THE third eclipse expedition to leave the United States for Sumatra to observe the total eclipse of the sun on January 14, 1926, sailed on the *President Harrison* from San Francisco on November 7. The party consisted of Dr. Harlan True Stetson, assistant professor of astronomy of Harvard University, Dr. W. W. Coblentz, physicist of the U. S. Bureau of Standards, Mr. Weld Arnold, explorer from the Amazon Expedition under Dr. Hamilton Rice, and Mr. William A. Spurr, Harvard '25, a student in astronomy. The primary object of the expedition will be the measurements of radiation from the solar corona by means of vacuum thermocouples, and photometric studies of the color and brightness of the corona by photographic methods. The radiometric work will be essentially the same in character as was carried out by the joint party from Harvard University and the Bureau of Standards, at Middletown, Connecticut, last January 24, but with improved equipment. The apparatus, consisting of a specially modified reflecting telescope of 20-inch aperture with radiometric and photometric accessories, left Boston on the *President Harrison* on October 7. The party will establish headquarters at Benkoelen on the west coast of Sumatra, and is due to arrive there about December 20. At Benkoelen also will be located the expedition from Swarthmore College.

THE manuscript for Professor Strand's "Biographical Entomological Dictionary," notice of which appeared in SCIENCE for November 7, 1924, page 431, will be sent to the press during the Christmas holidays. Any entomologists or arachnologists who have not yet submitted a sketch of their lives are urged to do so without delay. Sketches may be sent direct to Professor Embrik Strand, director of the Systematic Zoological Institute, Universität of Kronvalda bulvars 9, Riga, Latvia. Professor H. P. K. Agersborg, James Millikin University, Decatur, Illinois, or Professor C. L. Metcalf, University of Illinois, Urbana, Illinois, Natural History Building, will forward such sketches.

THE eighteenth annual meeting of the American Institute of Chemical Engineers will be held at the Hotel Sinton, Cincinnati, Ohio, from December 2 to 5. The local committee in charge of the meeting includes G. C. Smith, *chairman;* H. J. Morrison, Finance; R. S. Tour and G. D. McLaughlin, Papers; A. Campbell, Hotels; C. P. Long and C. B. Cluff, Entertainment; P. Thompson, R. F. Reed, E. R. Theis, W. P. Bande, K. F. Ludwig and L. A. Stegemeyer. Mrs. H. J.

Morrison heads the Ladies' Committee and Miss Aimee V. Pace is the official hostess of the City of Cincinnati. Thomas Quinlan, the convention director of the Cincinnati Chamber of Commerce, will also assist the committee.

AT the Sixth Congress of the Far Eastern Tropical Medicine Association, which was opened at Tokyo on October 12, it was decided at its closing session that the next congress should be held in India.

THE New York Tuberculosis and Health Conference is being held from November 19 to 20 at the Hotel Biltmore and the Academy of Medicine, New York City. Some of the speakers are Dr. William H. Welch, director, School of Hygiene and Public Health, the Johns Hopkins University, Baltimore; Dr. Theobald Smith, president of the National Tuberculosis Association; Dr. Livingston Farrand, president of Cornell University; Dr. Allen K. Krause, the Johns Hopkins University Medical Department; Dr. Charles J. Hatfield, of the Henry Phipps Institute, Philadelphia; Dr. Lawrason Brown, of the Trudeau Sanatorium, Saranac Lake; Dr. Edward W. Archibald, McGill University Faculty of Medicine, Montreal; Dr. Frankwood E. Williams, of the National Committee for Mental Hygiene; Dr. Sanger Brown, of the New York State Commission for Mental Defectives; Dr. Frank J. Monaghan, New York City Commissioner of Health; Dr. Matthias Nicoll, Jr., New York State Commissioner of Health, and Surgeon-General Hugh S. Cumming, U. S. Public Health Service.

THE Sigma Xi Alumni Association of the University of Pittsburgh, the secretary of which is Dr. Richard Hamer, held its first meeting for the year 1925–26 on November 9. A program was presented by the chemistry department, as follows: "Some developments in microscope illumination," A. Silverman; "Recent progress in electro-organic chemistry," A. Lowy; "Electrolytic reduction of salicylic acid to salicylaldehyde," K. S. Tesh; "Electrode potentials," G. Stegeman; "Contact catalysis," C. J. Engelder; "Colorimetric analysis through the use of the selenium cell," E. V. Hjort, and "Phosphorus compounds in plants," C. G. King.

IN a recent note (SCIENCE, LXII: 412–413. 1925) concerning the program of the International Congress of Plant Sciences to be held in Ithaca, N. Y., in August, 1926, no secretary was named for the taxonomy section. It may now be announced that Professor K. M. Wiegand, of Cornell University, will act as secretary of this section. All communications concerning sectional matters should be addressed to him.

THE Boston Society of Natural History is planning a series of radio talks on various subjects in natural history which will be broadcast on alternate Wednesday evenings at half past seven, from the Westinghouse Electric Company station WBZ at Springfield, Mass., and WBZA at Boston. Mr. Thornton W. Burgess has kindly allowed the use of part of the weekly half hour allotted to him by these stations for his "Burgess Radio Nature League," and the actual broadcasting will be under his supervision. While the plan calls for popular talks suitable for the younger generation they are also prepared to interest older persons and will be given to specialists in several fields so that there will be no question about the accuracy of the material presented. A large number of these talks will be given by the museum staff, others by members of the society and some by the staff of the Museum of Comparative Zoology at Harvard University. Among those already on the program are Dr. John C. Phillips, Dr. Glover M. Allen, Dr. Thomas Barbour, Mr. C. W. Johnson, Dr. H. B. Bigelow and Dr. Francis Harper, the new secretary of the society.

THE editor of SCIENCE has received several criticisms of the advertisement printed in SCIENCE entitled "The Soul of Motion." This is an interesting and ingenious toy, based on the principle of a differential thermometer. The advertisement in SCIENCE, beginning with the statement "The Soul of Motion is equivalent to creative life" and continuing with the statement that it explains colloids, the Brownian movement, radium emanations, etc., was intended to attract attention to the toy, but a number of the readers of SCIENCE appear to have supposed that the statements were intended to be taken seriously.

UNIVERSITY AND EDUCATIONAL NOTES

WE learn from *Industrial and Engineering Chemistry* that in the will of the late Mrs. E. B. Eddy the sum of $200,000 was provided to establish a chair of industrial chemistry at McGill University, Montreal, and that the Hon. George Elie Amyot, legislative councilor of the province of Quebec, has donated $100,000 to Laval University for the endowment of a chair of chemistry in the recently established school of chemistry.

PROFESSOR RUFUS L. GREEN has been made head of a new department of mathematics at Stanford University which has been formed by the combination of the mathematics department and a portion of the department of applied mathematics. Some of the courses and faculty members of applied mathematics have been transferred to the new School of Engineer-

ing. Professor Everett P. Lesley will occupy the position of executive head of the department of mechanical engineering for the present academic year.

DR. BRUCE M. HARRISON, assistant professor of zoology at Iowa State College, has recently resigned to take the position of associate professor of zoology at the University of Southern California.

AT the University of Chicago, Dr. Nathaniel Kleitman has been appointed assistant professor of physiology, Dr. Paul R. Cannon assistant professor of pathology, and Fred B. Plummer assistant professor of geology. Dr. Charles Philip Miller has been made an assistant professor in medicine on the Douglas Smith Foundation to do research work abroad.

ANDREW IRVING ANDREWS, for the past year professor of ceramic engineering at the New York State School of Clay Working and Ceramics, Alfred, N. Y., has been appointed assistant professor of ceramic engineering at the University of Illinois, Urbana, Ill.

DR. ARTHUR D. KNOTT has been appointed to the position of acting professor of preventive medicine at the Medical College of Virginia, Richmond, to take the place of Dr. Ernest C. Levy, who is on indefinite leave of absence.

DRS. WILLIAM E. DEEKS, Carlos P. Chagas and Alexander H. Rice have been appointed lecturers in tropical medicine at the Harvard School of Public Health, Boston.

A CHAIR of epidemiology has been created at the Collège de France at Paris and Professor H. Vincent appointed to it. Dr. Vincent was general medical inspector of the French army until his retirement on reaching the age limit.

DISCUSSION AND CORRESPONDENCE

A PLAN FOR THE PROMOTION OF SMALL MUSEUMS

IN recognition of the growing importance of small museums, the American Association of Museums has embarked upon an effort to assist in the establishment and reorganization of small institutions and to promote the interests of all museums in the smaller communities. The project—or series of projects—has grown out of extensive field work during the past year.

PROJECT I—DISSEMINATION OF INFORMATION

There are relatively few small museums that have trustees who are in touch with the museum movement or who recognize the importance of employing a trained director, and in consequence there are many untrained persons in charge of such institutions. This accounts in large part for the present underdeveloped condition of many museums.

It is felt that, as a first step, information concerning museum ideals and practices should be disseminated to those interested in the progress of small museums and to persons of influence in whose hands new museums may be organized. There is need for a comprehensive but simple and compact treatment of museum principles and methods to serve as the basis of this endeavor, and consequently the executive secretary of the association has undertaken to prepare a "Manual for Small Museums."

Effort to broadcast this body of information should involve direct approach to museum trustees, publicity through book reviews, magazine articles and the daily press and work through national organizations which can reach the leading citizens of any community.

PROJECT II—TRAINING OF MUSEUM WORKERS

If *Project I* should meet with success, a general scrutiny of small museums might ensue, and an increased demand for trained museum workers might develop. In anticipation of this outcome it is planned to provide now for the training of a limited number of directors.

Directorship of a small museum is specialized work, calling for a range of information, understanding of people and skill in museum technique. Despite these requirements, the pay will be relatively small. It is felt that the work will make greatest appeal to women of experience in other fields of service, and that training afforded such candidates ought to be of a practical kind.

Plans are being developed to organize instruction with the help of several museums—each contributing a course in some one or two subjects in which its work excels. If only one or two students are assigned to each museum at a time, and if periods of training be sufficiently long, it should be possible for the museums to count upon a certain amount of real help from the student assistants. This is desirable both as a protection to the interests of the museum and as a guarantee of thorough instruction to the student.

The entire problem of training for museum work is being studied by a committee of the association, of which Dr. S. A. Barrett is chairman.

PROJECT III—GRANTS FOR SALARIES

Although *Project I* might develop genuine desire for a trained director in a number of small communities and *Project II* might produce enough directors to supply the demand, still financial limitations

would probably prevent employment of the trained workers in many instances. In order to bring the demand and the supply together it may be desirable at a later time to make efforts to secure grants to enable small museums to employ directors for three or five years.

PROJECT IV—PUBLIC SUPPORT OF MUSEUMS

Success of *Project III* should equip a number of small museums for community service. In each of such museums the director would doubtless regard it as a first duty to place the finances of the institution on a safe permanent basis, and to this end help could be given.

Public support is the strongest financial bulwark of a small institution, but the success of any museum in securing county or municipal appropriations must depend upon the character of legislation in the state. There are only ten states in which the legislature has made provision for museums, and in five of these states the laws are quite inadequate. Therefore the association has determined to work for uniform and improved laws.

PROJECT V—COOPERATION OF MUSEUMS

The life and virility of any museum depends in part upon the relations which it maintains with other museums. Since small museums are more apt to be benefited by help from their near neighbors than from institutions far away, and since the expense involved in sending representatives to state conferences would be small, it seems desirable to promote the establishment of state or regional museums organiaztions. Although the American Association of Museums desires to give assistance to regional groups, it does not intend to exercise any centralized administrative control.

In undertaking this promotion, the association is mindful of the misfortunes that would attend standardization of museums, and therefore freedom of local initiative is to be safeguarded. However, the small museums of America do need counsel and help, and with just these abetments from the national body, they may ultimately attain to much importance.

LAURENCE VAIL COLEMAN,
Executive Secretary.
NEW YORK, N. Y.

DEFINITE EVIDENCE OF HUMAN ARTIFACTS IN THE AMERICAN PLEISTOCENE

GOOD, dependable definite evidence of human artifacts in the Pleistocene in America has at last been found. Many geologists and investigators have been expecting such evidence to be turned up, and many interesting discoveries are of course recorded, by many people from several states. Among the more important of these are the famous Vero and Melbourne, Florida, discoveries; those at Dallas Sand Pits, Texas, and the Nebraska Loess Man. But in most cases, however, these discoveries were made under conditions which make the geological evidence of their antiquity subject to possible question, in varying degrees.

In the present instance, fortunately, the evidence is so dependable that no reasonable doubt can exist that the artifacts and fossil animals found are contemporaneous, and that the animals and artifacts are in original, undisturbed Pleistocene deposits.

The first work leading up to this discovery was done early in the summer of 1924. After seeing pieces of fossilized bone from the locality, Director J. D. Figgins, of the Colorado Museum of Natural History, Denver, authorized and outfitted an expedition to southwestern Texas, under the leadership of Mr. H. D. Boyes; and the work of excavating was begun with the assistance of Mr. Nelson Vaughan, who made the original discovery, and reported it to Director Figgins. About the first of May, 1925, at the request of Director Figgins, the writer went to the locality, examined the quarry and vicinity and checked the geology of the region.

In 1924, Messrs. Boyes and Vaughan collected most of the associated skeleton of a splendidly preserved fossil bison and parts of other individuals and animals. In taking up a large block, with the articulated vertebrae and ribs in position, the first artifact was found, under the cervical vertebrae. A second similar point was found on the under side of the femur of this bison. A third point was found in position with the body of this skeleton; but this latter point was lost or stolen before it could be packed in the field for shipment. These artifacts are large arrow points or small lance points. They are, very unexpectedly, of very fine workmanship, much more refined and beautifully worked than the arrow and spear points of the more recent types in that region, and of quite distinct culture and design. Hundreds of examples of the stone artifacts of two more recent cultural stages were observed in that region by the writer, and there is no question that the more recent work is far more crude, and made by a distinct people, of distinct culture.

In examining the geology of the region it became apparent that the old eroded, rather shallow valleys, cut into Triassic and Cretaceous beds in that region, had for a while refilled during Pleistocene time; and

that subsequent erosion has recut the old valleys down to about the same point they originally were; but in so doing, the newer cut is often somewhat narrower than the former valley, leaving undisturbed Pleistocene remnants along the sides of the valleys. An area some hundred and twenty-five miles in extent was examined by the writer, and similar conditions were noted over quite an extended area, whose limits are not exactly known. The deposit in which the bison and artifacts noted was found is such an old remnant, and is obviously undisturbed. Only a narrow strip of Pleistocene beds remain between the present stream erosion and the old Triassic former valley wall.

The bison and other fossils occur in solidly cemented gravels, overlain by about five to seven feet of undisturbed Pleistocene sands and gravels, that are cemented so hard by calcareous cement that the beds are worked with difficulty, especially when dry. On top of these sands is a disturbed bed of uncertain age, and above this several feet of worked-over sands, silts and soil. The bones found are all well fossilized, and in a state that it would be utterly impossible for erosion to have moved them, without breaking them up and disarticulating the bones, and largely destroying them. Every observed condition clearly points to an undisturbed deposit, and free from such cross-channeling as has worked the materials over at Vero, Florida. The bison pertains to one of the earliest stages of the refilling process in laying down these Pleistocene gravels and is just above the old Triassic floor. It is probable that the bison had been shot and carried these flint points with him to the place where he finally died and was entombed.

Mr. Vaughan went with the writer to this locality and over the region. Further excavation showed the presence of other bones in position; and the deposits were examined for more than a mile up the little valley of Lone Wolf Creek, above the quarry site. Similar bones and associated types of animals were found in all places where fossils could be located. In these lower beds, beside the extinct bison, a large species of *Elephas, Equus* and a camel probably belonging to the genus *Camelus* or *Camelops* were discovered, and some other unidentified bones. All fossils found were broken up and scrappy, with the exception of the bison—as is usually the case and to be expected in beds containing so much coarse gravel. Only in isolated cases is it possible to hope to find an associated skeleton in these deposits. The bison belongs to a large species, considerably larger than the modern species, but as yet it has been impossible to give it comparative study and accurate identification. It is mounted and on exhibition in the Colorado Museum of Natural History, Denver, and is a beautiful specimen. The *Elephas* has as yet only had field determination, but belongs to the type closely related to what has been commonly considered the *Elephas columbi* type. The *Equus* is a large species and is represented, as is the *Elephas,* by teeth and lower jaws and odd fragments of bone; but in view of the large number of proposed species in that genus, until close comparisons can be made, no more exact identification is desirable. It is probable that a detailed study of this fauna will make it possible to assign the beds to a definite stage in the Pleistocene.

Mr. Nelson Vaughan has been scouring the region this summer (1925) for further material. As yet his collections are not unpacked for study; but no further articulated skeletons have been found. More detailed reports will shortly appear in the publications of the Colorado Museum of Natural History.

The location of these finds is a point near the Colorado River, near the southeastern end of the Staked Plains, and near the little town of Colorado, Texas, on Lone Wolf Creek.

At present the following points stand out clearly. There is no possibility of accidental inclusion of these artifacts with the bison, or of their being of later age. *They are certainly and positively contemporaneous with that fossil bison and the associated fauna of mammoths, camels and extinct horses*—of a type found elsewhere in beds of known Pleistocene age. Until more detailed studies are made, however, it is not possible to state the age of the deposits more definitely, or to what phase of the Pleistocene they belong.

HAROLD J. COOK

AGATE, NEBRASKA

EGGS SUPPOSED TO BE LUMINOUS

IN my study of Semitic superstitions (comparative religion) I have accumulated a large body of information from many lands relative to *cultus* offered to the "Jack-o'lantern" as a ghost of the dead. In all this lore it is associated with decomposing animal matter, garbage heaps, shallow graves, old privies, kitchen middens, shell-mounds, etc., as well as with marshlands, etc. (The savage mind does not distinguish between the "Jack-o'lantern" drifting in the air as high as the treetops sometimes, and the stationary electric phenomena known as "St. Elmo's Fires," and the local phosphorescence of decayed wood, putrid fish, etc.)

Now, some of the old oriental myths associate mysterious "divine" lights with swan's eggs in the marsh, roc's eggs (see the geni of Aladdin's "lamp" whose "father" was a "roc's egg") and ostrich eggs, which are to-day hung in oriental tomb shrines. This leads me to think that such luminous exhalations or emanations had certainly been observed in connection with

such eggs. I see no reason why such luminous phenomena might not be connected with eggs, as well as with other decomposing animal matter. But I should like to know if any scientific chemist has actually observed such fact. The folk-lore is voluminous and unanimous.

A. H. GODBEY

CARRSVILLE, KENTUCKY

THE CONSERVATION OF BEAVER BY AN INDIAN

JIM LAKNITZ, a Gitksan Indian, one of the two leaders in the village of Kitwanga, British Columbia, has an ancestral beaver trapping ground where he is trying to conserve the beaver. The place is an artificial lake formed by a beaver dam about four miles south of the totem poles of Kitwanga. He will neither trap beaver at this place nor allow any one else to do so, but he makes frequent patrols to watch and guard his beaver as he wants them to replenish the trapping ground so he can have good beaver trapping for himself and to leave to his nephew, who in his tribe would be his successor.

How is this for conservation?

HARLAN I. SMITH

VICTORIA MEMORIAL MUSEUM,
OTTAWA, CANADA

ANDRÉ PARMENTIER AND THE BROOKLYN BOTANIC GARDEN

IN SCIENCE for October 23, 1925 (p. 368) is a news item stating that, "The memory of André Parmentier, horticulturist and founder of the Brooklyn Botanical Garden, was honored on October 17 at the unveiling of a tablet within the garden near the entrance at Eastern Parkway."

André Parmentier never had anything to do with the present Brooklyn Botanic Garden. He was a pioneer landscape gardener and nurseryman, who came to this country in 1825 from Belgium and conducted a nursery which was very remarkable for its day. He called his nursery the "Horticultural and Botanic Garden of Brooklyn." It was located about one mile from the location of the present Brooklyn Botanic Garden on an area which is now entirely built over. Its area was about twenty-five acres.

So far as known, this nursery was the first institution in Brooklyn to be called a botanic garden. Of course it only remotely resembled a botanic garden as the term is now understood, and it had no historical or other connection with the present Brooklyn Botanic Garden. The credit for the founding of the present Brooklyn Botanic Garden is due chiefly to the late Mr. Alfred T. White.

The significance of Mr. Parmentier's work lay largely in the fact that he was a pioneer, blazing the trail for horticulture and for beauty in gardening in a place where such work was sorely needed.

C. STUART GAGER

BROOKLYN BOTANIC GARDEN

QUOTATIONS

"MILLIKAN RAYS"

DR. R. A. MILLIKAN has gone out beyond our highest atmosphere in search for the cause of a radiation mysteriously disturbing the electroscopes of the physicists. This was more difficult of determination than the mathematical location of a planet which had not been seen by any astronomer. The study had to be made out upon the edge of what the report of his discovery calls "finite space," many miles above the surface of the earth in balloons that carry instruments of men's devising where man himself can not go. His patient adventuring observations through twenty years have at last been rewarded. He has brought back to earth a bit more of truth to add to what we knew about the universe. There is no human satisfaction that can be greater than adding even a fragment to the body of ascertained truth.

He found wild rays more powerful and penetrating than any that have been domesticated or terrestrialized, traveling toward the earth with the speed of light and yet of almost unimaginably short wavelengths, shorter than the ultra violet waves, shorter even than the waves of the X-rays and the gamma rays of radium, beating ceaselessly beyond the ken of the known spectrum, probably completing its alphabet for the language by which the stars communicate with man. These immigrant rays come out of the "depths of outer space" into our highest atmosphere with an energy that, it is intimated, might be disastrous to the earth if it were to continue to increase, but do not at present come in such numbers as to be menacing. There is no possibility of the human production of these rays except at the expenditure of an impracticable energy. The author of "The Great Analysis" said a few years ago that there was nothing unknown this side of the moon, but here are these till now unknown and even now mysterious forces playing in the great spaces between our earth and the moon—forces of whose origin we know no more than we do of the origin of life on the earth itself. Even the mammal whose ten-million-year-old bones have been found in the same rocky nest with the unhatched dinosaur eggs does not remember the first day of Genesis.

The mere discovery of these rays is a triumph of

the human mind that should be acclaimed among the capital events of these days. The proposal that they should bear the name of their discoverer is one upon which his brother-scientists should insist. The power of these rays to pass through six feet of solid lead has suggested the name "penetrating rays," and the fact that they are immigrants upon this vapor sphere has suggested the name "in-coming rays"; but they would more appropriately bear the name of the penetrating mind that passed through the miles of space to the far frontiers of our atmosphere and there met these strange forces of the universe coming out of space—the mind that lived among them for years to learn their ways, and at last brought us word of their mysterious existence. "Millikan rays" ought to find a place in our planetary scientific directory all the more because they would be associated with a man of such fine and modest personality.—New York *Times*.

SCIENTIFIC BOOKS

The Climates of the United States. By ROBERT DECOURCY WARD, professor of climatology in Harvard University. Ginn & Company, 1925; 21 by 15 cms, 518 pp., 1 map in color and 145 figures in the text; price $4.00.

THIS book differs from the usual run of text-books, though a college text-book it unquestionably is. It is cleverly camouflaged in appearance and content; and nine out of ten old graduates will not suspect its real character, while eight out of ten eagle-eyed undergraduates, always suspicious of a professor's offering, will after reading the book admit that it is good stuff. And that is high commendation from critical, calculating youth.

The book will appeal to the general reader for various reasons. One is the absence of tables. When in a treatise on climatology extensive tables of mean temperatures, maximum, minimum, mean maximum, mean minimum temperatures, relative humidities, pressures and wind directions are suppressed, it is a sure sign that the author cares little for show and much for the story back of such data. This is one reason why the book is positively entertaining.

Instead of loading paragraphs with details, Professor Ward has kept these within bounds (wisely, we think); but he furnishes numerous footnotes and extensive references.

The opening chapters on the development of climatological work, major climatic controls and the climatic provinces of the United States are presented in a readable manner, details coming in later chapters. The fourth chapter takes up the weather element in our climates; and we are given a full discussion of weather types, which varying seasonally and regionally make up the average sum-total known as climate. There are sixteen figures of storm paths and typical disturbances ranging from winter storms over the northern Plains to the hurricane on the South Atlantic Coast. It would have been a step in the right direction if pressure values in these illustrations had been given in units of force. These take less room in printing and make for clearer conceptions of the magnitude of the pressure gradient. For example, in the typical hurricane (see page 60) instead of 29.30 inches at the center and 30.20 inches at the border of the "high," there might have been printed -8 and +22. Then the student at a glance appreciates the steepness of the slope. He sees a depression of 0.8 (of one per cent.) contrasted with an excess 2.2 per cent. In other words from north to south there is a gradient of three per cent. of a standard atmosphere. Also it would have been an improvement if Professor Ward had broken away from Fahrenheit temperatures. True, the slow-moving people of these United States cling to the scale devised by the German instrument maker in 1714; yet no German today uses that scale; and there are some seven hundred million people in the world—not counting our own chemists, physicists and men of science generally—who have scrapped it.

The chapter on temperature, the longest in the book—fifty pages—is a mine of information. We must, however, call attention to the charts of lowest and highest temperature ever observed (Figs. 47 and 48). These are based upon the climatic charts of the United States, official but inaccurate and misleading. Professor Ward in the text gives records which contradict the chart values. Following the discussion of temperature, we have rainfall and prevailing winds. In the diagrams of types of rainfall, values are given in millimeters as well as in inches; which is in accord with British practice. We wish our Weather Bureau would get in step with the rest of the world.

The use of correlation coefficients in the discussion of rainfall is avoided. Of late this method has been somewhat overworked. It has been shown, for example, that there is a high correlation between the rainfall at Jerusalem and the growth of the Sequoia gigantea in California. This has been discussed elaborately in some treatises on quaternary climates; yet who can believe for a moment that there is any direct causal relation between these two sets of data?

Snowfall, humidity, sensible temperature, sunshine, cloudiness and fog are treated at some length. There is an interesting paragraph on dark days; and we are told the incident of the interruption of proceed-

ings in the legislature of Connecticut on May 19, 1780, when the doughty Davenport of Stamford protested against adjournment:

> Either the day of judgment is at hand or it is not. If it is not there is no cause for adjournment. If it is, I wish to be found in the line of my duty. I wish candles to be brought.

As a loyal son of Harvard, the professor might have stretched space a little to tell of that good President Wigglesworth who on this same day read his Bible by a window. There had been thunder and rain in the morning. At 11 o'clock fowls went to roost. At 12:21 Mr. Wigglesworth, the darkness still increasing, could not read the running title of the large Bible. Candles were lit. At 1:12 the degree of light was the same as at 11 o'clock, which was determined by Mr. Wigglesworth's reading. So the day wore on. Observations of pressure and temperature were made every hour. A detailed account of the happenings on this day was kept by Nathan Read, a student at Harvard, and is now in the possession of the Essex Institute.

Tornadoes, cold waves, northers and blizzards are discussed; also hot waves, sunstroke weather and the Indian summer.

Concluding chapters deal with climate and health and climate and crops; and the final chapter is on the climates of Alaska. We are pleased to note the plural. It is well to have an authoritative word on this, because of the popular impression that rigorous weather is the rule. Indeed, one of the world flyers lately, when asked about the climate of Alaska, answered that there were only two seasons—this winter and the next. On the contrary, notwithstanding great contrasts, there are many localities where climate is not essentially different from that of our North Pacific states.

General Greely's "Handbook of Alaska" (third edition, 1925) will be found of great value to those interested in this matter.

Professor Ward has done a good service to all university instructors in climatology and economic geography by assembling in one convenient volume the essential facts of climatic conditions in the United States. His twenty-five years' experience as a teacher has enabled him to meet the needs of teachers and students primarily; but also he has given us a volume which agriculturists, medical men, business men and others may profit by reading.

The book deserves and probably will have a wide circulation.

ALEXANDER MCADIE

BLUE HILL OBSERVATORY

SPECIAL ARTICLES

FLAMES OF ATOMIC HYDROGEN

A STUDY of the heat losses from tungsten filaments at very high temperatures in an atmosphere of hydrogen led the writer to conclude in 1911[1] that hydrogen is largely dissociated into atoms at temperatures of 2500°K or more. The total heat loss from the filament after subtracting that due to radiation increased in proportion to the 7^{th} power of the temperature at temperatures over 2700°K, whereas the normal heat loss by convection, as determined for example in nitrogen, should have increased with the 1.8^{th} power of the temperature. Further work showed[2] that by heating a platinum or tungsten filament above 1300°K in hydrogen at low pressures, atomic hydrogen was formed which had very remarkable properties. It would dissolve at ordinary temperatures in platinum and would be condensed on glass surfaces at room temperature and at this temperature combined instantly with oxygen, phosphorus and reduced oxides such as WO_3, CuO, Fe_2O_3, ZnO or PtO_2. More accurate measurements of the heat losses from tungsten filaments in hydrogen at various pressures[3] gave 90,000 small calories as the heat of combination of 2 grams of atomic hydrogen, and showed that the degree of dissociation at atmospheric pressure increased from about 2 per cent. at 2400°K to about 34 per cent. at the melting point of tungsten.

In attempting to obtain the Balmer spectrum of hydrogen without contamination by the secondary spectrum, R. W. Wood[4] built very long vacuum tubes in which he passed currents of amperes through moist hydrogen at a few millimeters pressure. He observed many remarkable phenomena. Short pieces of tungsten or platinum wire mounted in a side tube became heated to incandescence, although no electric current flowed through this tube and the glass walls near the wires were not heated strongly. These effects were nearly absent when the hydrogen was carefully dried. In correspondence with Professor Wood, the writer suggested that these effects were due to high concentrations of atomic hydrogen which could accumulate in the tube because of the effect of water vapor in poisoning the catalytic activity of dry glass surfaces that otherwise destroyed the atomic hydrogen. With moisture present the atomic hydrogen diffused through

[1] Langmuir, Trans. Amer. Electrochem. Soc. 20, 225 (1911) and Jour. Amer. Chem. Soc. 34, 860 (1912).

[2] Langmuir, Jour. Amer. Chem. Soc. 34, 1310 (1912); Freeman, Jour. Amer. Chem. Soc. 35, 927 (1913).

[3] Langmuir and Mackay, Jour. Amer. Chem. Soc. 36, 1708 (1914), 37, 417 (1915) and 38, 1145 (1916).

[4] R. W. Wood, Phil. Mag. 44, 538 (1922).

the side tube and the atoms combined to form molecules on the surfaces of the metallic wires which acted as catalysts.

Shortly after this correspondence it occurred to the writer that it should be possible to obtain even higher concentrations of atomic hydrogen by passing powerful electric arcs between tungsten electrodes in hydrogen at atmospheric pressure. The high heat conductivity of the gas due to the energy liberated by the recombination of the rapidly diffusing atoms should prove of particular value in the construction of electric furnaces, and for melting metals in general. Experiments of this kind were soon made. Twenty ampere arcs from a constant current transformer were passed between two tungsten rods 6 mm. in diameter mounted transversely in an alundum tube (10 cm. diam.) through which a stream of hydrogen flowed and burned at the open end.

Arcs up to 2. cm. in length were obtained with voltages ranging from 300–800. The arc, of a beautiful red color, was of small diameter (about 3 mm.) and was bowed out into a fan shape by its own magnetic field.

Iron rods 2 or 3 mm. in diameter melted within a couple of seconds when they were held 3–5 cm. above the arc. By directing a jet of hydrogen from a small tube into the arc, the atomic hydrogen could be blown out of the arc and formed an intensely hot flame of atomic hydrogen burning to the molecular form and liberating 90,000 calories per gram molecule—about 50 per cent. more than that in an oxy-hydrogen flame. To maintain these conditions the electrodes had to be brought closer together (preferably 1–3 mm.).

In this flame, even at distances of 1 or 2 cm. from the arc, it was found that molybdenum melted with ease, and tungsten rods of 3 mm. diameter could be melted when held very close to the arc itself. Quartz, on the other hand, melted with more difficulty than molybdenum, indicating that the catalytic action of the metals played an important part in the rapidity with which they could be heated.

The use of hydrogen under these conditions for melting metals has proved to have many advantages. Iron can be welded or melted without contamination by carbon, oxygen or nitrogen. Because of the powerful reducing action of the atomic hydrogen, alloys containing chromium, aluminum, silicon or manganese can be welded without fluxes without surface oxidation. The rapidity with which such metals as iron can be melted seems to exceed that in the oxy-acetylene flame, so that the process promises to be particularly valuable for welding.

The technical development of these welding processes using flames of atomic hydrogen has been the work of several men, among whom Robert Palmer and R. A. Weinman must be particularly mentioned. Papers describing the apparatus used and the results obtained will soon be published by Mr. Weinman and the writer in the *General Electric Review*.

Mr. P. Alexander, following out a line of development suggested by Professor Elihu Thomson, has independently arrived at an arc welding process utilizing hydrogen for the purpose of improving the ductility of the weld and the speed of operation. In this process the arc is passed between an iron electrode and the material to be welded. This process also depends at least in part on the use of the high heat conductivity of atomic hydrogen.

Some joint work of Mr. Alexander and the writer has shown that particular advantages are obtained in some cases by using mixtures of nitrogen and hydrogen, and that the quality of the weld is not impaired by nitrogen unless oxygen is also present. A paper by Mr. Alexander describing his process will appear simultaneously with those dealing with the atomic flame process.

IRVING LANGMUIR

RESEARCH LABORATORY,
GENERAL ELECTRIC CO.,
SCHENECTADY, N. Y.
OCTOBER 27, 1925

THE BINDING OF ACID AND ALKALI BY PROTEINS

WE have recently published[1] an extensive study of acid and alkali binding by proteins with especial reference to the mechanism involved in such binding and the relations which may exist between the chemical composition of the protein and the amount of acid or alkali which it binds at certain definite hydrogen-ion concentrations.

Inasmuch as the cited publication may not be generally available to persons interested in this subject, we have felt that it might be advantageous to briefly state certain of the conclusions which we arrived at in the course of our study.

The study included the isolation, purification and chemical analysis of a series of fourteen proteins. Twelve of these were isolated from the cereal grains and belong to the class of prolamines, the alcohol-soluble proteins of cereals. These proteins were isolated from the seeds of *Triticum vulgare, Triticum*

[1] Walter F. Hoffman and Ross Aiken Gortner, "Physico-chemical studies on proteins I. The prolamines—their chemical composition in relation to acid and alkali binding," Colloid Symposium Monograph, Vol. 2, pp. 209–368, 110 tables, 20 figs., 1925. The Chemical Catalog Company, New York City.

spelta, Triticum monococcum, Triticum dicoccum, Triticum durum, Secale cereale, Avena sativa, Zea mays, Hordeum vulgare, Sorghum vulgare, Andropogon sorghum, and *Euchlaena mexicana* Schrad. The remaining two proteins, casein from cow's milk and fibrin from blood, were included in the series for the purpose of enabling us to compare the behavior of the prolamines with proteins of a radically different type.

The chemical analyses which were carried out included an elementary analysis of such proteins as had not previously been isolated, the nitrogen distribution in the proteins as measured by Van Slyke's method, the true amide nitrogen values, the free amino groups in the native proteins, the free carboxyl groups in the native proteins and the cystine and tryptophane content.

The analyses showed that we had selected a series of proteins which varied sufficiently among themselves to serve to demonstrate as to whether or not the chemical composition of the protein controlled the binding of acid and alkali as Loeb[2] contends or whether acid and alkali binding are colloidal phenomena and are largely independent of the nature of the individual amino acids in the protein molecule, as has been the contention of certain other investigators.

The analyses showed that the amide nitrogen of this series of proteins ranged from 6.93 per cent. of the total nitrogen to 25.34 per cent., the arginine nitrogen from 3.90 to 14.16 per cent., the histidine nitrogen from 1.19 to 10.36 per cent., the lysine nitrogen from 0.42 to 14.06 per cent., the total basic nitrogen from 8.24 to 33.41 per cent., the free amino nitrogen in the native protein from 1.02 to 8.95 per cent., the cystine content from 0.27 to 3.72 per cent. and the tryptophane content from none to 4.40 per cent.

The acid and alkali binding was studied, making use almost exclusively of the modern potentiometric methods for studying changes in hydrogen-ion concentration. In connection with the preliminary work using these methods, we discovered that the degree of ionization of an acid or base, or in more modern parlance, the activity of an acid or a base, had a different value when measured by potentiometric methods than when the measurements are made by the use of electrical conductivity apparatus. Inasmuch as the standard tables indicating the extent of dissociation of acids and bases at various dilutions have been calculated from conductivity data, it follows that such tables can not be utilized to calculate hydrogen-ion concentrations which are later to be compared with values of hydrogen-ion concentrations determined by the potentiometric methods. The inaccuracy of such comparisons had not previously been recognized by workers in this field, and as a result appreciable errors were introduced into their experimental findings, and they were caused to draw erroneous conclusions. The paper of Lloyd and Mays[3] may be cited as a typical example.

As a result of the foregoing observation, we have not only revised the methods of experimental procedure for measuring alkali and acid binding, but we have altered the formula which has previously been used to calculate the amount of acid or alkali which was bound. We believe that our methods of measurement and of calculating the results yield as accurate data as the present state of physico-chemical knowledge permits. There is always the possibility of postulating the rôle which the "protein ions" may play in influencing the hydrogen-ion concentration of the equilibrium mixture. Certain workers insist on introducing such calculations into their formula, basing the justification for such a procedure upon theoretical or hypothetical grounds, and admitting at the same time that we have no means at the present available of proving whether or not the "protein ions" do in reality influence the "activity" of the hydrogen ions in the equilibrium mixture. Inasmuch as no exact data are available, we have preferred to believe that "protein ions," if they are present as such in the equilibrium mixture, do not influence the activity of the hydrochloric acid in the equilibrium mixture, and have made all our calculations on this assumption. The experimental readings are presented in detail in the publication referred to, and any one is at liberty to recalculate them in whatever manner he may see fit. We wish to point out, however, that we are fully aware of the possibility of calculating our data by other methods, but that we believe such calculations would introduce as many, if not more, hypothetical and possibly erroneous assumptions than the method which we have selected. The reader of this note must be referred to the original publication for a complete description of our methods and the 110 tables of experimental data and calculations.

The experimental data, interpreted on the basis of the assumptions which we have felt justified in making, indicate very clearly the following conclusions.

Approximately equivalent amounts of hydrochloric, sulfuric and phosphoric (molar) acid were bound by

[2] Loeb, J., "Proteins and the Theory of Colloidal Behavior," McGraw Hill Book Company, New York, 1922. See also SCIENCE 52: 449–56, 1920.

[3] Lloyd, D. J., and Mays, C., *Proc. Roy. Soc.* 93 B, 69–85, 1922.

a unit amount of protein, when the acids are compared on the normality basis. Equal amounts were not bound at the same equilibrium hydrogen-ion concentration as is claimed by Loeb, much more phosphoric acid than hydrochloric acid being bound.

A marked negative temperature coefficient was obtained when the experiments on the binding of hydrochloric acid and sodium hydroxide were carried out at 15°, 25° and 35° C. and when the final hydrogen-ion concentration was more than pH 2.5 and the hydroxyl-ion concentration was more than pH 10.5. The ratio was approximately 1:2:3 where the amount bound at 35° is 1. When the logarithms of the equivalents of acid or alkali bound at the different temperatures were plotted against the logarithms of the equivalents of acid or alkali added, the lines for a single protein passed through common points. For acid this point represented a hydrogen-ion concentration of about pH 2.5 and for alkali, a hydroxyl-ion concentration of about pH 10.5.

Experiments were carried out where more dilute acid and alkali were used, in an attempt to determine the behavior of acid and alkali binding between the hydrogen-ion concentrations represented by pH 2.5 and pH 10.5. Here the amount of acid or alkali bound apparently depends on the chemical composition of the protein. The buffer curve does not form a smooth line. When the logarithms of the equivalents of acid or alkali bound in this pH region are plotted against the final pH, the curves do not form a straight line. It is suggested that there are two types of combinations between proteins and acid or alkali: (1) chemical type of combination which takes place when the hydrogen-ion concentration is between pH 2.5 and pH 10.5 and (2) an adsorption type of combination which takes place when the hydrogen-ion concentration is greater than pH 2.5 or the hydroxyl-ion concentration is greater than pH 10.5.

Evidence of a chemical type of combination[4] between a hydrogen-ion concentration of pH 2.5 and pH 10.5 is presented by:

(1) The logarithms of the amount of acid or alkali bound plotted against the original concentrations do not form a straight line.

(2) The buffer curves do not form a smooth, regular line.

(3) The amount of acid or alkali bound at any hydrogen-ion concentration between pH 2.5 and pH 10.5, depends on the chemical composition of the protein. This is not true where the pH is less than 2.5 or greater than 10.5.

Evidence of the adsorption type of combination is furnished by:

(1) At the higher concentrations of acid and alkali, all the proteins used in this work, *regardless of their chemical composition,* bind approximately the same amount of acid or of alkali.

(2) There is a marked negative temperature coefficient of the acid or alkali binding at the higher concentrations of acid and and alkali.

(3(The logarithms of the amount of acid or alkali bound plotted against the logarithms of the original acid or alkali concentration or against the final pH form a straight line.

(4) There is more alkali bound when the original concentration is 0.500 normal than can be accounted for by chemical combination assuming that there is an available carboxyl group for each nitrogen atom, an assumption far in excess of possibility.

The analytical data in regard to the amino acid content of prolamines are not sufficiently accurate to enable final conclusions to be drawn as to the chemical groups responsible for the chemical binding of alkali. In the case of acid binding, however, a correlation of $r = 0.9923 \pm 0.00275$ was found between the free amino nitrogen of the protein as determined in the Van Slyke apparatus and the equivalents of acid bound at pH 2.8, and a correlation of 0.9918 ± 0.00312 was obtained between the sum of the free amino nitrogen plus one fourth of the arginine nitrogen (the free amino group of the guanidine nucleus) and the equivalents of acid bound at pH 2.5. As already noted, the character of acid binding changes at pH 2.5.

If the isoelectric points are calculated by extrapolating the logarithmic curves of the second type, the acid and alkali curves intersect in the neighborhood of pH 7, the neutral point as referred to water. This is the case when the isoelectric point was calculated from, (1) the logarithms of the amount of acid or alkali bound by the proteins and the logarithms of the original concentration of acid or alkali, (2) the logarithms of the amount of acid or alkali bound and the equilibrium pH and (3) the logarithms of the amounts of acid or alkali added, and the equilibrium pH. The isoelectric point of the protein, *i.e.,* the hydrogen-ion concentration of the protein sus-

[4] Certain workers, of whom Loeb was the outstanding exponent, prefer to call such compounds formed between proteins and hydrochloric acid "protein-chlorides," and between proteins and sodium hydroxides "sodium proteinates." Such terminology may correctly indicate the nature of the compounds formed. Proof to that effect, however, is not at present forthcoming and accordingly we have purposely avoided such terminology, preferring to state that a "chemical type of combination" takes place and not making any assumptions at present as to the nature of the compounds formed.

pended in water, determined potentiometrically, does not in a number of instances agree with these extrapolated values but is found to be in the neighborhood of the values reported in the literature as determined directly by cataphoresis or other methods. The measured isoelectric "point" of a protein probably is not a definite point but should in all probability be referred to as an "isoelectric range." *The position of this isoelectric range on the pH scale is dependent on the chemical composition of the protein.* The calculated isoelectric point is very near the hydrogen-ion concentration of neutral water. This is what would be predicted on the theory that at the higher concentrations of acid and alkali the binding of acid and alkali follows the adsorption law. *The calculated isoelectric points are not related to the chemical composition of the proteins.*

From these findings we conclude that the chemical nature of a protein and the power of a protein to bind acid and alkali in stoichiometrical relationships depends upon the chemical groups within the protein molecule and is therefore limited to the range between pH 2.5 and pH 10.5. Thus our findings afford a logical explanation for the divergent views of Loeb *et al.* and other workers who hold that acid and alkali binding are of a stoichiometrical chemical nature and those workers who insist that colloidal adsorption is the predominating factor. *Both are correct,* and we have shown in what regions (in terms of hydrogen-ion concentration) one or the other phenomenon may be expected to predominate.

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

ANNUAL REPORT OF THE PERMANENT SECRETARY FOR THE FISCAL YEAR 1924-25[1]

THE permanent secretary reports as follows concerning the work of the association during the year 1924–25 and plans for the year 1925–26.

PUBLICATIONS

A special issue of SCIENCE (February 6, 1925) was arranged to present the general reports of the fifth Washington meeting. Special reports of associated societies were presented in subsequent issues of SCIENCE. The issue of February 6 was sent to all members, including those who receive *The Scientific Monthly.* The usual booklet on the organization and work of the Association was revised and was again used in the circularization of new members of the affiliated societies. About 7,000 circular letters inviting such persons to join the Association were sent out October 1, 1925. About 4,000 more letters are to be sent out. The official statement of the Association on the status of the Evolution Theory was printed as a leaflet for use at the time of the Scopes trial and later. Additional copies of this leaflet are available if needed. The new volume of summarized proceedings is nearly off the press. Its publication is expected within the next few weeks. The work of proof-reading has been in the hands of Dr. Sam F. Trelease, of Columbia University. In the preparation of the manuscripts the permanent secretary has been greatly assisted by the Washington staff. One new feature of the volume is an annotated list of all the organizations that are associated with the Association, each name being followed by a brief statement concerning the organization, secured from its secretary. With the help of the editor of SCIENCE plans have been made by which the preliminary announcement of the Kansas City meeting is to appear in SCIENCE for Friday, November 27, 1925. This issue is to be sent to those who receive *The Scientific Monthly* as well as to the regular subscription list of SCIENCE. It is hoped that this arrangement will prove to be an improvement. A considerable expense will be thereby avoided.

DIVISION AND ACADEMY RELATIONS

The arrangements with the two divisions have been continued as heretofore. The new arrangement with affiliated academies is going into effect smoothly. Division allowances amounted to $1,746 for the fiscal year 1924–25. The allowances to the affiliated academies and the local branch amounted to $1,540; this item will probably be only about half as large for next year, under the new arrangement.

MEETINGS

The fifth Washington meeting was by far the largest in the history of the Association and it was successful in many ways. Full reports concerning it have been published. There were two summer meetings of the Association in 1925, one held jointly with the Southwestern Division (at Boulder, Colo., June 8–11) and the other held jointly with the Pacific Division (at Portland, Ore., June 17–20). The two summer meetings cost the association the sum of $782.42,

[1] Presented to the Executive Committee on October 25, 1925.